

Nuclear Instruments and Methods

João B. Manteigas

The strategy of the group involves activities in the following lines:

1. Modelling of radiation fields, calculation of neutron physic parameters, measurement of neutron cross-sections;
2. Modelling of gas discharges;
3. Development of software for control and data analysis;
4. Design of electronic instrumentation for nuclear applications;
5. Instrumentation and technical assistance.

Modelling of radiation fields, calculation of neutron physic parameters

Monte Carlo calculations have been carried out in the framework of the EUROTRANS Project (IP EUROTRANS, 516520), the CANDIDE Project (Coordination Action on Nuclear Data for Industrial Development in Europe, 036397), and the n_TOF Collaboration (ITN participation on the n_TOF-phase 2 experiment at CERN).

Measurement of neutron cross-sections

The analysis of the data for cross-section measurement, taken in the TOF spectrometer installed at the CERN, was carried out.

Modelling of gas discharges

1. A code for the simulation of atomic emission spectra in plasmas was developed and included in the PLASMAKIN plasma modelling package. The code is able to deal with all relevant line broadening processes and with radiation trapping under complete frequency redistribution conditions.
2. The effect of small admixtures of molecular gases on the electron kinetics in argon, with application on GD-OES (Glow Discharge Optical Emission Spectroscopy) was studied. The molecular gases studied included H₂, N₂, O₂ and H₂O in concentration up to 10%.
3. The study of the oxidation of methane in DBD (dielectric barrier discharges) was started. Two discharge reactors were built and the conversion efficiency of methane and the selectivity for H₂, CO and CO₂ studied.

Development of software for control and data Analysis

1. A system for control of gamma spectrometry equipment was developed. The system uses a client-server architecture based on the EPICS system for instrument communication and control and allows the remote control of a multichannel acquisition board.
2. The effect of interference on measurements and on critical and detection limits was studied and applied to the simultaneous measurement of gross alpha and beta activity measured either with gas proportional counters or with liquid scintillation counting.

Design of electronic instrumentation

- Triple Power Supply/Readout System, “Mass Flow Controller”, designed to control 3 Mass Flow Meter/Controller from Bronkhorst® High-Tech B.V., Holland, *in-situ* and remotely.
- Optimization of Gamma Isotope TLC Analyser, “RadioScan” (for measuring and recording radioactivity levels, on label or strips) and upgrading of “Portable Gamma Level Indicator” – DNG-P.

Instrumentation and Technical Assistance

The main objectives are the development of equipment for ITN groups, fabrication of equipment for specific applications and assistance to industrial companies and scientific institutions as well as technical consulting. The technical assistance takes mainly the forms of specialised consultant engineering advice, installation of nuclear gauges, including calibration maintenance and repair and recharging of gauges with imported radioactive sources.

Co-operation with other institutions

The Group was involved in the following collaborations:

1. n_TOF collaboration, a consortium of 40 laboratories in Europe and USA;
2. International project EU 5th FP IP-EUROTRANS, collaboration with CIEMAT (Spain) and others.
3. Research Institute for Solid State Physics and Optics, Budapest, Hungary.
4. Plasma Physics Centre / Gas Electronics Group, IST;
5. ISEL, Department of Automation and Electrotechnical Engineering.

Researchers

J. MANTEIGAS, Aux., (Group Leader)
C. CRUZ, Aux.
I. F. GONÇALVES, Aux.
J. NEVES, Aux.
N. PINHÃO, Aux.(90%)

Students

C.M.CARRAPIÇO, Ph.D. Student, IST (IG)
A. JANEKO, Project Grantee (NP)
R.P.F. MENDES, Graduation Student, FC/UL (NP)

Technical Personnel

T. JESUS
N. INÁCIO
M. CABAÇA

Technical Assistance in the Field of Engineering Applications of Radiation and Radioisotopes

J.B. Manteigas, J. Neves, C. Cruz

Objectives

The main objectives are the development of equipment for internal groups, fabrication of equipment for specific applications and assistance to industrial companies and scientific institutions as well as technical consulting.

Results

A summary of the more relevant work carried out is:

- (i) Collaboration in corrective and preventive maintenance of the “Ion Beam Laboratory – TANDEM 3 MV” at the Physics Sector.
- (ii) Collaboration with CIEMAT (Spain) in the framework of international project EU 5th FP IP-EUROTRANS. In order to minimize noise

susceptibility of experiments, some technical work on grounding and shielding was carried out at Yalina facility on the Joint Institute of Power and Nuclear Research, Sosny, Minsk, Belarus.

- (iii) Collaboration on Automation-Robotic of the Multidisciplinary Laboratory of Controlled Areas (“Concurso N^o2/ITN/REEQ/2008”).
- (iv) Collaboration on the construction of the Multidisciplinary Laboratory of Controlled Areas (“Concurso N^o3/ITN-REEQ/2008”).
- (v) Development and maintenance of electronic equipment to RPI, Physics, Chemical, UTR and DPRSN Sectors.



Summary of the more relevant Services/Equipments rendered in 2008

Activity	Qty	Client
Laboratory equipment for the determination of radioactive element traces by electrodeposition Personal Radiation Dosimeter Equipment	1	UNIWERSYTET GDANSKI (Poland)
	2	FARMA APS
	2	PREVINAVE (República Popular de Angola)
	2	J. ROMA, LDA.
	2	Instituto de Ciências de Materiais de Barcelona (6 Channel Micro Current Sources)
Electronic Nuclear Instrumentation	1	PREVINAVE – República Popular de Angola (Portable Level Indicator)
Technical Assistance to Nuclear Equipment	1	ITN/UPRSN (RADIOSCAN)
	1	ITN/UCQR (Mass Flow Controller)
	1	ITN/UPRSN
	1	Direcção Geral de Navios
	20	EMA 21 – PORTUCEL/SOPORCEL (Figueira da Foz)
	6	SIDERURGIA NACIONAL SA (Seixal)
Prices including TAX (VAT)		Total Amount: 17 300,18€

Participation of ITN in the n_TOF phase 2 experiment at CERN (3rd year)

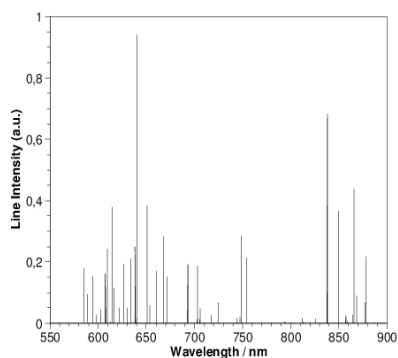
I.F. Gonçalves, P. Vaz, C. Cruz, J. Neves, C. Carrapiço, R. Sarmiento, L. Távora¹

The n_TOF phase2 project is the continuation of the involvement of ITN in the activities of the n_TOF Collaboration. The intention of the n_TOF Collaboration is to build a second n_TOF beam-line and a new experimental area (EAR-2) using a shorter flight path (20 meters), with lower backgrounds and count rates in the detectors, making possible the extension of measurements to higher energies and the availability of a higher neutron flux (a factor of 100).

A team of researchers of ITN has been involved in Monte Carlo simulation activities, data analysis and development of electronics for the BaF2 calorimeter. ITN is strongly involved in collaboration with INFN-Bari and CEA, Saclay, in the following areas: Monte Carlo simulation - full and detailed simulation of the geometry of the new experimental area, computation of the particle fluxes, assessment of the backgrounds, with the usage of the state-of-the-art Monte Carlo codes MCNPX and GEANT-4; Data analysis (I) - continuation of the analysis of the following data sets: Au-197, Np-237, Pu-240, taken during 2005 using the BaF2 calorimeter. The data analysis was initiated in 2006 and it is foreseen that will continue till 2009; Electronics developments for the DAQ and the BaF2 calorimeter.

Development of open source software for the simulation of atomic emission spectra

N. R. Pinhão

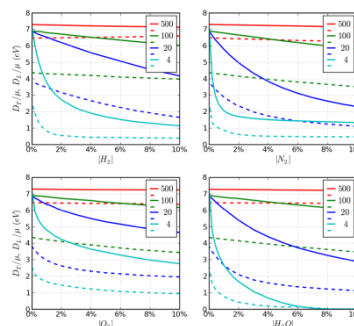


We developed a software code for the simulation of atomic emission spectra of discharge plasmas in either plane-parallel or cylindrical geometries. Line profiles take account of combined natural, Doppler and pressure broadening effects. Pressure broadening includes van der Waals collisions, resonance broadening and quadratic Stark broadening from collisions with charged species (electrons and ions). The resulting combined line profiles are approximated by the sum of a Voigt profile with a correction term. Radiation trapping is taken into account assuming complete frequency redistribution. The code has been included in the Open Source PLASMAKIN package for plasma modelling.

Electron kinetics in gas mixtures used for Analytical Glow Discharge Optical Emission Spectroscopy

Z. Donkó, N. R. Pinhão, M. J. Pinheiro, P. Hartmann

The electron kinetics in argon with small admixtures (from 0% up to 10%) of molecular gases (H_2 , N_2 , O_2 and H_2O) was studied. Electron energy distribution functions, transport parameters and reaction rates were compared using three different numerical methods: a two-term Boltzmann equation solver, a density gradient expansion for the Boltzmann equation and a Monte-Carlo method. The results show a strong influence of small amounts of admixture (< 1%) in low electric field. As the field increases this influence becomes less important.



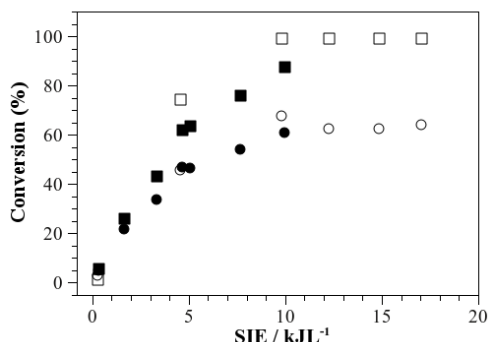
Development of a distributed system for data acquisition and treatment in gamma spectrometry

R. P. F. Mendes, N. R. Pinhão

A system for remote control of gamma spectrometry equipment was developed. The system uses a client-server architecture based on the EPICS system for instrument communication and control over TCP/IP. Data acquisition is done on a PC running a real-time Linux kernel, acting as a server, and equipped with a multichannel acquisition board. Data treatment can be done in any PC running a client application. The project has included the development of a Linux device driver for the EG&G 916A multichannel board.

Oxidation of methane using CH₄/O₂/He and CH₄/CO₂/He mixtures in dielectric barrier discharges

J. Branco, N. R. Pinhão, A. Janeco, A. G. Ferreira, L. Redondo, A. P. Gonçalves



The oxidation of methane in non-thermal plasma produced in a dielectric barrier discharge (DBD) has been studied in two different systems: one with a needle-to-plane (dielectric) geometry and another one with cylindrical geometry. A maximum value for CH₄ conversion of 70% was obtained with a mixture of CH₄/O₂/He and a Specific Input Energy (SIE) of 10 kJ/L. This study is integrated in the project “Coupling catalysts and a non thermal plasma for low temperature decomposition of organic volatile compounds”, discussed elsewhere.

Effect of Interference on Detection Limits for the Simultaneous Measurement of Gross Alpha and Beta Activities

N. R. Pinhão, J. Abrantes

The effect of interference on measurements and on critical and detection limits was studied, developed for the case of two mutually interfering analyte and applied to the simultaneous measurement of gross alpha and beta activity measured either with gas proportional counters or with liquid scintillation counting. A new and simple criteria for the detection threshold in the presence of interference was proposed. The detection limit was split into a component independent of interference and characterizing the measurement process, and a term dependent on interference.